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Use of Intra-aortic balloon pump in Ischemic Heart Disease Patients with Impaired Left Ventricle: 7 Years' Experience in MTI-HMC, Peshawar, Pakistan

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Abstract

Objectives: This study evaluates the outcomes of intra-aortic balloon pump (IABP) use in high-risk patients with impaired left ventricular (LV) function (EF ≤45%) undergoing coronary artery bypass grafting (CABG).

Methodology: A retrospective analysis of 1683 CABG patients identified 481 with significant LV dysfunction, of whom 55 (11.4%) required IABP support at Hayatabad Medical Complex (2018–2025). Data from these 55 patients were analyzed for outcomes and predictors.

Results: Mean age was 59.4 ± 10.5 years, mean EF 33.9 ± 3.7%. Most were male (81.8%), with comorbidities including hypertension (45.5%) and diabetes (29.1%). Mean CPB time was 166.1 ± 30.0 minutes; 98.2% received LIMA-LAD grafting. Most (90.9%) underwent elective CABG, while 5.5% required emergent CABG (e.g., ventricular septal rupture). Postoperative outcomes included in-hospital mortality (38.2%), re-intubation (29.1%), and arrhythmias (23.6%).

Conclusion: IABP is an effective first-line mechanical support in high-risk CABG patients with LV dysfunction, with better outcomes when inserted early intraoperatively. However, its use remains associated with increased mortality. Further prospective studies are needed to optimize its role.

Keywords: Intra-aortic balloon pump (IABP); CABG; LV dysfunction; Cardiac surgery; Mortality

1. Introduction

The intra-aortic balloon pump (IABP), a device for mechanical circulatory support, was first introduced in humans by Moulopoulos et al in 1962. [1]. Later, Kantrowitz et al. [2] reported that 1 of 3 patients with cardiogenic shock due to myocardial infarction who were unresponsive to medical therapy survived following the application of an IABP. Intra-aortic balloon pump (IABP) is the most frequently used tool for temporary mechanical circulatory support in patients of cardiac surgery suffered from decrease cardiac output in the early postoperative phase.

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More than 70,000 patients are supported by IABP annually only in the United States. [3, 4]. Counter-pulsation with IABP is an acceptable supportive therapy to pharmacological inotropic medication in patients with reduced cardiac output syndrome during perioperative period for cardiac operations. IABP enhance myocardial oxygen delivery by increasing diastolic coronary blood flow while decreasing afterload and hence work load of left ventricle [5]. Patients with hemodynamic instability due to myocardial ischemia get the most benefit from the use of an IABP in critical clinical conditions [6, 7].

On the other hand, the patients requiring an IABP often have high hospital and 30-day mortality rates, ranging from 26% to 50% due to underlying cardiac conditions that necessitate the use of the pump [8-10]. Timing of IABP insertion seems to be important for getting best outcomes. As preoperative insertion is associated with 18.8– 19.6% mortality [11]. While mortalities for intraoperative and postoperative insertions are 27.6–32.3% and 39–40.5%, respectively [11]. Based on the results, it has been suggested that preoperative prophylactic IABP insertion could be considered for high-risk patients [12]. However, others consider this strategy unnecessary if adequate myocardial protection is achieved along with the administration of inotropes such as epinephrine/norepinephrine and milrinone. Our hospital does not routinely use a prophylactic IABP strategy.

This study retrospectively evaluates our experience with IABP use during the perioperative period in cardiac surgical patients, who required IABP insertion based on their specific clinical situation. Single center experience reports are valuable for assessing the benefit of clinically driven rather than prophylactic IABP use in patients undergoing cardiac surgery.

2. Materials and methods

2.1. Study design and setting

We conducted a retrospective study of 1683 patient files undergoing CABG surgery, in which 481 patients who underwent CABG for CAD had significant LV dysfunction. Out of the 481 significantly impaired LV patients, 55 patients required IABP support at Hayatabad Medical Complex, Peshawar, Pakistan; between 2018 and 2025. Data were extracted, for these 55 patients requiring IABP insertion, from clinical records and analyzed statistically to evaluate outcomes and predictors. Ethical approval was obtained from the institutional research and ethics board.

2.2. Patient population

The patients (n=55) had a mean age of 59.36 ± 10.513 years and a mean ejection fraction of 33.89 ± 3.705%. There were 45 (81.8%) male patients with common comorbidities, including hypertension (25, 45.5%), diabetes mellitus (16, 29.1%), and smoking (3, 5.5%). Patient demographics, including age, sex, and risk factors such as diabetes, hypertension, smoking, renal failure, cerebrovascular disease, and a history of prior percutaneous coronary intervention, were collected. is given in (Figure 1).

2.3. Data collection

After the ethical approval, data were collected retrospectively from hospital records of 1683 patient files undergoing CABG surgery, in which 481 patients who underwent CABG for CAD had significant LV dysfunction. Out of the 481 significantly impaired LV patients, 55 patients required IABP support at Hayatabad Medical Complex, Peshawar Pakistan: between 2018 and 2025. The collected information from clinical records; including preoperative, intraoperative, and postoperative variables, for these 55 patients requiring IABP insertion, were A detailed flowchart of study selection extracted from their clinical records and analyzed statistically. All patients underwent preoperative two-dimensional echocardiography for assessment of the heart structures and physiology including LV functions as well as catheter coronary angiography as per standard protocols before subjecting to CABG surgery.

2.4. Surgical procedure

All patients followed a standardized anesthetic protocol, 2which included fentanyl, midazolam, and pancuronium for induction, with maintenance provided using isoflurane and propofol. CABG was performed through a median sternotomy, with the left internal mammary artery (LIMA) and saphenous vein harvested for grafting. Cardiopulmonary bypass (CPB) was established after administering heparin (300 IU/kg) to ensure a target-activated clotting time of at least 450 seconds. Myocardial protection was achieved using a modified Del-Nido cardioplegia, administered both antegrade through the aortic root and retrogradely via the coronary sinus. Complete revascularization was performed in all patients using conventional surgical techniques. After all anastomoses were completed and the patient was weaned off CPB, heparin was reversed with protamine to restore normal clotting function.

2.5. Postoperative management

At the conclusion of surgery, patients were transferred to the intensive care unit (ICU) for close monitoring and management. This included optimizing ventilatory support, ensuring hemodynamic stability, maintaining normothermia, and balancing fluid, electrolytes, and temperature status. Weaning off the ventilator and extubation were performed once patients regained consciousness, demonstrated sufficient respiratory effort and acceptable arterial blood gas levels, achieved hemodynamic stability, maintained normothermia, and showed no signs of excessive bleeding. Insertion of IABP was commenced in operating room if the patient would fail to come off-CPB or would not maintain optimum hemodynamics after coming off-CPB with high dual inotropic support (≥0.2 mics of each Adrenaline and Nor-Adrenaline). Insertion of IABP in the ICU would be commenced if the patient would hemodynamically deteriorate despite high multiple inotropic support (including ≥0.2 mics of each Adrenaline and Nor-Adrenaline) or would arrest in the ICU despite high inotropic supports.

2.6. Outcome variables

The primary postoperative endpoint was all-cause mortality. Secondary outcomes included re-operation for bleeding or tamponade, arrhythmias, respiratory failure, stroke, ventilation duration, re-intubation, length of ICU stay, in-hospital death, and early mortality.

2.7. Statistical analysis

Data were collected retrospectively and analyzed using IBM SPSS Statistics for Windows, Version 20 (Released 2011; IBM Corp., Armonk, New York). Continuous variables were expressed as mean ± standard deviation, while categorical variables were reported as frequencies and percentages. Associations between preoperative, intraoperative, and postoperative variables and outcomes were assessed to identify predictors of complications and mortality.

3. Results

Patients who undergone CABG with severe LVD and required IABP in this cohort (Table-1).

Among the study participants, 25 (45.5%) had a history of hypertension, while 16 (29.1%) had diabetes mellitus. Smoking was present in 3 (5.5%) of the patients. Preoperative renal impairment was observed in 1(1.8%) of the participants. Additionally, one (1.8%) patient had a prior history of cerebrovascular accident (CVA), and 7 (12.7%) had undergone prior percutaneous coronary intervention (PCI). These findings highlight the common presence of multiple cardiovascular risk factors and comorbidities in patients with severe LVD undergoing CABG (Table *1*).

3.1. Intraoperative variables

The mean duration of CPB was 166.13 ± 30.013 minutes, while the mean cross-clamp time was 98.05 ± 15.104 minutes. The average length of ICU stays following the procedure was 61.56 ± 28.004 hours, and the mean duration of ventilation was 30.78 ± 35.771 hours. Complete revascularization was achieved using left internal mammary artery to left anterior descending coronary artery (LIMA to LAD) in 54 (98.2%) of the patients. While 4 (7.3%) of the patients received multiarterial grafts. Re-exploration was required in 7 (12.7%) cases. Cardioplegia was administered using both antegrade and retrograde cardioplegia in all 55 patients. These intraoperative findings underscore the surgical strategies and variability observed in the CABG procedures for patients with severe LVD (Table *2*).

3.2. Postoperative outcomes

Postoperative complications were assessed to determine early surgical outcomes following CABG. Postoperative renal failure occurred in seven (12.7%) patients, while postoperative CVA was observed in four (7.3%). Additionally, postoperative respiratory failure was reported in ten (18.2%) cases. Two patients required IABP in ICU because of not maintaining pressures despite high inotropic support. Among these 55 patients who needed IABP 21 (38.2%) died. Re-intubation was required in 16 (29.1%) patients. Arrhythmia was noted in 13 (23.6%) of the cases. These findings highlight the notable risks and complications associated with CABG in patients with severe LVD, emphasizing the need for careful monitoring and management in the postoperative period (Table *3*).

Out of 55 patients 3 (5.5%) required mitral valve replacement. Also 4 patients (7.3%) undergone VSR repair. The urgency of surgical intervention was categorized to assess the clinical presentation and associated risk factors in the study population. Among the 55 patients included, 50 (90.9%) underwent elective CABG, representing planned and stable revascularization procedures. Two (3.6%) required urgent CABG due to worsening clinical conditions, while three (5.5%) underwent emergent CABG, most associated with VSR, a life-threatening complication following acute myocardial infarction. These findings highlight the diverse clinical presentations and the varying levels of risk involved in CABG procedures, with emergent surgeries carrying the highest degree of complexity and hemodynamic instability (Table 3), and [Figure-1].

Table 1 Baseline demographic and clinical characteristics of the study population undergoing coronary artery bypass grafting (CABG)

Variable	Frequency/Mean (SD)
Age (years)	59.36 ± 10.513
Ejection fraction (EF) %	33.89 ± 3.705
No of grafts	4.16 ± 0.811
Gender n (%)	
Male	45 (81.8)
Female	10(18.2)
Comorbid Condition n (%)	
Hypertension (HTN)	25(45.5)
Diabetes mellitus (DM)	16 (29.1)
Smokers	3(5.5)
Pre-op renal impairment	1(1.8)
Prior CVA	1(1.8)
Prior PCI	7(12.7)

CVA: cerebrovascular accident; PCI: percutaneous coronary intervention

Table 2 Intraoperative variables in coronary artery bypass grafting (CABG) procedures

Variable	Frequency/Mean (SD)
CPB time (minutes)	166.13 ± 30.013
Cross-clamp time (minutes)	98.05 ± 15.104
ICU stay (hours)	61.56 ± 28.004
Ventilation time (hours)	30.78 ± 35.771
Values in n (%)	
LIMA to LAD	54 (98.2)
Multiarterial grafts	4 (7.3)
Re-exploration	7 (12.7)
Cardioplegia methods: both	55 (100)

LIMA: left internal mammary artery; LAD: left anterior descending artery; ICU: intensive care unit; CPB: cardiopulmonary bypass

Table 3 Postoperative outcomes and study endpoints

Study Endpoints	**Frequency**	**Percent (%)**
Post-op renal failure	7	12.7%
Post-op CVA	4	7.3%
Post-op respiratory failure	10	18.2%
In-hospital mortality	21	38.2%
Re-intubation	16	29.1%
Arrhythmia: yes	13	23.6%
Concomitant procedures		
Mitral valve replacement	3	5.5%
VSR repair	4	7.3%
Urgency of surgery		
Elective	50	90.9%
Urgent	2	3.6%
Emergent	3	5.5%

CVA: cerebrovascular accident

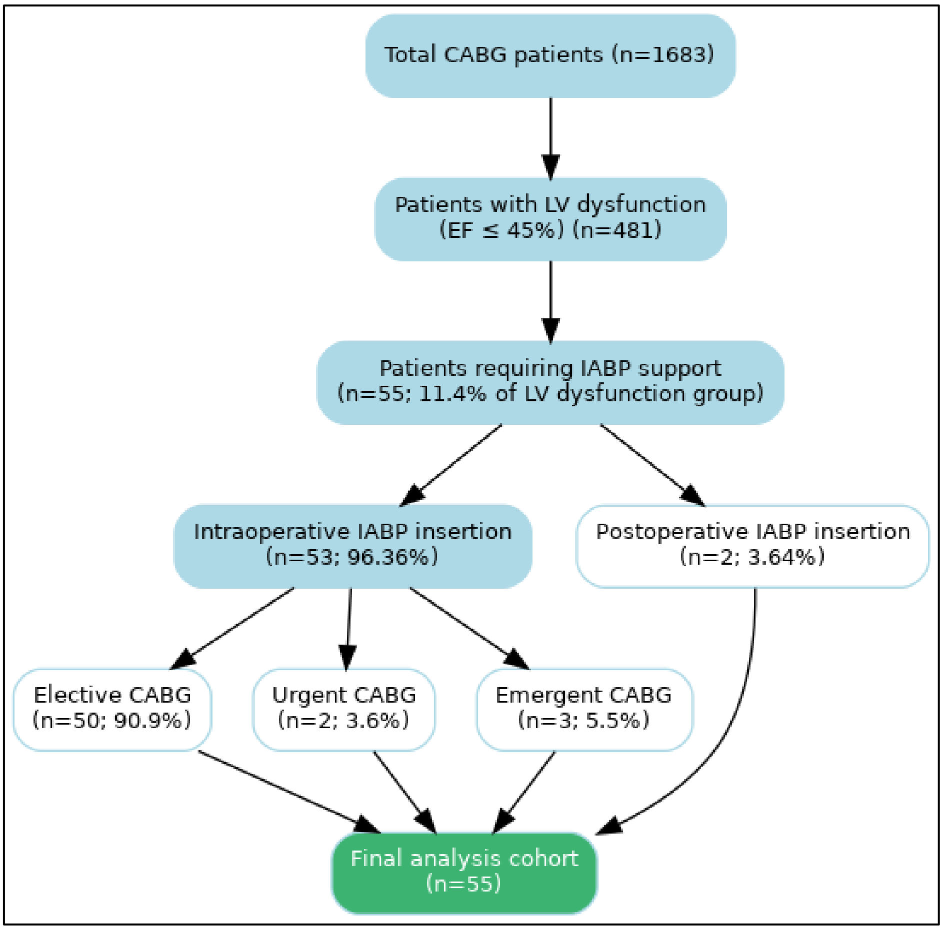

Figure 1 The clinical and analysis pathway for the study population

4. Discussion

IABP usage was first outlined in 1968 by Kantrowitz et al. for treatment of patients with cardiogenic shock due to myocardial infarction [2]. Over the years, criteria for IABP insertion have been broadened, and the number of IABPs used in cardiological as well as cardiac-surgical patients has been rising [3]. In addition to its use in cardiogenic shock due to myocardial infarction, the IABP is now commonly used for postoperative support in cardiac surgery patients with low cardiac output syndrome or those experiencing difficulty weaning from extracorporeal bypass [13]. IABP has been the most commonly used temporary mechanical assist device for managing of low cardiac output in patients undergoing cardiac surgery, serving as first line therapy for hemodynamically unstable patients despite maximal medication. IABP has two principal physiological effects; it improves coronary blood flow and myocardial oxygen supply by increasing diastolic perfusion pressure and reduces afterload by rapid balloon deflation in systole leading to reduced ventricular work and consequently decreased myocardial oxygen consumption [14]. Decreased mean capillary wedge pressure and total pulmonary vascular resistance with enhancement of subendocardial perfusion and increased cardiac index are other effects of IABP use [15–17]. Many patients now have multiple prior cardiac interventions before undergoing surgery and are often referred only after all interventional options have been exhausted. Despite significant advances in surgery and perioperative care for this high-risk surgical population, the mortality rates for cases requiring perioperative IABP remains high. Lavana et al. evaluated the association between timing of intra-aortic balloon pump insertion and outcomes of the patients reporting mortality rates as 10% in preoperative group, 16% in the intraoperative group and 29% in the postoperative group. They concluded that preoperative IABP use was associated with reduction in hospital mortality [18]. It is important to note that we utilized intra-aortic balloon pumps in fifty-five patients with only two (3.64%) being used postoperatively while fifty-three (96.36%) being used intraoperatively. In those fifty-five patients twenty-one patients (38.2%) died. Parissis et al. reported an overall mortality rate of 35.3% in 136 patients (5.4%) requiring IABP insertion among 2697 adult cardiac surgical patients. The mortality as per time of balloon insertion was reported as preoperative 18.2%, intraoperative 33.3% and postoperative 58.3% in their study [19]. While we have successfully performed a total of 1721 coronary artery bypass graft (CABG) surgeries at our hospital, we specifically collected records for 481 patients who had impaired left ventricular (LV) function and underwent CABG. Our analysis focused on the utilization of intra-aortic balloon pumps (IABPs) and the associated mortality rates in this patient group. So the overall mortality rate was 38.2% in 55 patients (11.4%) requiring IABP insertion among 481 adult cardiac surgical patients. We also did cardiac MRI in 35 patients among these in which two (5.4%) patients died [20]. Several clinical studies have demonstrated that prophylactic use of an IABP leads to reduced surgical mortality and postoperative morbidity in high-risk patients undergoing CABG surgery [21, 22]. However, other studies reported no survival benefit from the prophylactic application of an IABP in hemodynamically stable, high-risk patients undergoing bypass grafting, compared to placing of an IABP on an as-needed basis during or after surgery [23,24] .Baskett et al. reported that preoperative IABP was consistently associated with higher mortality expressing that they were unable to show benefit from preoperative IABP use [25,26,27].As prophylactic IABP insertion policy was not used, 53 IABP insertions were made intraoperative and two post operative and the overall mortality in them was 38.2%. Difficulty of weaning from CPB despite moderate doses of inotropes was our trigger for IABP insertion and we believe this strategy is superior to weaning with supranormal inotrope doses. In post operative patients our trigger for IABP insertion was low cardiac output despite being patients on high doses of inotropes. A review article assessing the IABP use in cardiac surgery, the overall mortality in patients receiving IABPs intra and postoperatively was reported to range from 21% to 73% [14,28]. Zaky et al. from Cleveland Clinic reported overall mortality rates with preoperative, intraoperative and postoperative IABP insertion as 12.6%, 17.5% and 47.7%, retrospectively [29,30]. The overall mortality in our study was 21 (4.37%) among 481 patients but those 55 patients who required IABP 21 (38.2%) died among them.

This retrospective study has several limitations, including potential selection bias and confounding factors due to the non-randomized use of IABP. The absence of a control group restricts the ability to draw definitive conclusions on its effectiveness. Additionally, incomplete data and the small number of postoperative IABP patients limit the generalizability of the results. As a single-center study, the findings may not be generalizable, and long-term outcomes were not evaluated. These limitations highlight the need for further prospective studies to validate the results.

5. Conclusion

IABP is a relatively safe and widely used first line mechanical support for low cardiac output syndrome during the perioperative period in CABG patients having impaired LV functions. This single center report shows the outcomes of IABP use, not prophylactically, but intra-operatively or post-operatively, in patients having severe LV dysfunction who needed mechanical support. Our findings suggest that IABP may be beneficial in improving hemodynamic stability in high-risk patients, particularly those with severe LV dysfunction. We recommend that surgeons facing difficulty weaning from CPB with moderate/high doses of inotropes should consider early intraoperative/post-operative IABP placement. However, the need for IABP during cardiac surgery should be recognized as a risk factor, indicating poor prognosis and an association with increase mortality.

Compliance with ethical standards

Disclosure of conflict of interest

All authors declare no conflict of interest

Statement of informed consent

This study is conducted on the data of hospital files and HMIS record with due ethical approval from the institution's ethical committee, without disclosing identity of individual patients. Hence informed consent from the individual patients is not applicable for this study.

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